

What Role Can Ontologies Play to Improve the Performance of Intelligent Systems?

Craig Schlenoff

Intelligent Systems Division

National Institute of Standards and Technology

There are at least three overarching questions that one may ask regarding the role of ontologies in performance evaluation. They are:

1. How can an ontology play a role in evaluating intelligent systems?
2. How can an ontology within an intelligent system be evaluated?
3. How can ontologies play a role in helping an intelligent system perform at a higher level of performance?

This write-up focuses on this third question.

When most people think about the role of ontologies in performance evaluation, they often ask question such as:

- What will be the purpose of the ontology?
- How formal of an ontology does one need?
- How does one create such ontologies?

To attempt to answer these questions, one can imagine introducing an ontology (or set of ontologies) into an autonomous vehicular system's knowledge base. Let's assume that the ontology consisted of various objects that the vehicle expected to encounter in its environment, as well as the important characteristics of each object. This ontology would help to answer question such as:

- Based upon the data we get from our sensors, what are the objects we perceive in the environment at the given time, with appropriate levels of confidence?
- What characteristics of those objects do I need to be most concerned about?

With the introduction of ontologies representing factors that effect the motion of objects (such as an ontology representing the "rules of the road", motion limitation of certain vehicles, the network of roads in the environment), we could answer questions such as:

- Where do we expect an object to be at a time in the future?
- What is our risk of colliding with the object assume the motion patterns do not change?

Assuming the ontology has clearly defined semantics, we can use the ontology to unambiguously exchange information among different autonomous vehicles (or between a vehicle and a human) that are working together to jointly accomplish a goal.

With the introduction of an ontology of actions that an autonomous vehicle is able to perform, we could answer questions such as:

- How can the overall goal of the vehicle be decomposed into actionable items?
- What are the appropriate actions in a given situation?

Based on these ontologies, if the entire environment around the vehicle at any given time could be completely modeled, we could evaluate the planner by answering questions such as:

- Has the planner identified all possible plans?
- Does the chosen plan truly accomplish the stated goal?

Therefore, I contend that ontologies can play a role in improving the performance of almost every part of autonomous vehicular systems, and most likely in intelligent systems as a whole.

However, that is not to say that there aren't various technical challenges that have to be addressed before ontologies can be used in this context. Some of the questions that need to be addressed include:

- How can ontologies be linked to other types of representations, including sensor data?
- Can ontologies respond quickly enough to be useful in a real-time environment?
- Are ontologies reusable in intelligent systems, and if so, what is the best mechanism to share them with each other?
- How can one evaluate the performance of the ontology?